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EFFECT OF FIELD AND STORAGE APPLICATIONS OF SPROUT INHIBITORS ON POTATO TUBERS

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Elmer (1936) observed that if potatoes and apples were stored in the same container sprout growth on the potato tubers was markedly reduced. Later this effect was shown to be a result of ethylene gas emanation by the apples. Following this discovery and the work of Guthrie (1938, 1939) on the effect of various growth regulators on sprouting in potato tubers, much work has been done on the problem of inhibiting sprouting in potatoes by chemical means. The great bulk of this work was done at Boyce Thompson Institute by Guthrie (1938, 1939), Denny (1942, 1945) and co-workers.

After much experimentation by these and other research workers it was found that the most effective chemical for sprout inhibition

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in potatoes was the methyl ester of alpha naphthaleneacetic acid (MENA). The best method of application appeared to be with a dust carrier. This dust was formulated in varying concentrations but a 2.2 per cent dust was the material used most generally for commercial application. This dust was applied at the rate of one gram of pure MENA per bushel of tubers.

This was the accepted commercial method adopted but it had several disadvantages; one being the necessity of employing various devices and methods to get good distribution in the storage and another being the severe irritation these dusts caused to the nasal passages.

Smith, Baeza, and Ellison (1947) reported successful reduction of sprouting of potatoes in storage following field treatment with various growth-regulating substances. Difficulties encountered, however, were severe injury to the vines and tubers from early dates of application as well as some reduction in yields.

Ellison (1948) carried this work further and found that sodium 2, 4, 5 trichlorophenoxyacetate was more effective as a sprout inhibitor than sodium naphthaleneacetate when applied as a field spray, 50 ppm sodium 2, 4, 5 trichlorophenoxyacetate being as effective as 3000 ppm sodium naphthaleneacetate.

As a result of Ellison's work it was decided that further research should be conducted on field and storage application of sprout inhibitors particularly various salts and esters of 2, 4, 5 trichlorophenoxyacetic acid (2, 4, 5-T), since this chemical had shown the most promise as a field spray. In addition, Ellison (1948) had shown that the sodium salt of 2, 4, 5-T was as effective as the sodium salt of napthaleneacetic acid (NAA) when the chemicals were injected into the tubers.

Part of the results of our 1948 experiments with these compounds will be given. These results will be divided into two phases, the field applications and the storage applications.

1948 Field Applications

Effect of various concentrations and dates of application on sprouting.

Since Ellison (1948) had found that the earliest date of application gave the best results but also the most injury, we decided to try lower concentrations at the early date of application. In addition we thought that perhaps several sprays of low concentration during the season might give a greater degree of sprout inhibition without the injurious effect of the same amount applied all at one time.

To test these factors we applied sprays to a field of Houma potatoes. These sprays were applied in several concentrations at three dates

of application and replicated 4 times. Sprays were applied with a knapsack sprayer at 100 gallons of spray per acre. The first application (E) was made when the vines were in full bloom; the second (M), two weeks later; and the third (L), four weeks after the first application. All sprays were various concentrations of the sodium salt of 2, 4, 5-T since this material is water soluble while the esters are not. The first application was made on the 26th of July; the second application on the 9th of August; and the third application on the 23rd. Yield records were taken and samples were saved for sprouting studies on the 6th of October. Ten tuber samples were stored at 50° F on the 20th of October. No injury was noted on any of the tubers in any treatment. This was rather surprising since Ellison (1948) had reported injury at similar concentrations a year earlier. The tubers were removed from storage, desprouted, weighed and records taken on the 2nd of April, 1949, approximately six months after harvest.

Table 1 shows the various treatments with the yield per plot and the subsequent shrinkage in storage expressed as per cent of original tuber weight. Other shrinkage is the shrinkage not accounted for by the actual sprout weight. Table 1 shows, in general, that the effect of the chemical is greatest at the early date of application and that the effect is cumulative. For instance, 25 ppm at full bloom and again two weeks later is more effective than is 100 ppm applied only two weeks after full bloom. This again indicates that the more logical time to apply such sprays is as early in the development of the plant as is possible without injury to the vine or tubers.

The overall picture from table 1 indicates that at the most effective concentration applied, namely 50 ppm full bloom; 100 ppm, two weeks later; and 200 ppm, four weeks after bloom; sprout growth was reduced only about fifty per cent and other shrinkage much less than that. It is questionable whether or not this reduction is sufficient to warrant field applications on a large scale although a reduction in shrinkage from ten per cent to five per cent on one thousand bushels of potatoes would be a saving of approximately 50 bushels of potatoes. So in large lots it might well be a rather considerable saving. No significant reduction in yield was found from any treatment.

In view of these results further tests are being conducted on higher rates of application at the earlier date. In addition experiments will be conducted to determine the effect of subsequent inhibitor application in storage after a field spray with a uniform treatment. It is possible that such an application may very markedly reduce storage sprouting of potatoes at rather high temperatures (50-60F.)

Effect of 2, 4, 5-T sprays on different varieties:

During the 1948 season certified seed of six varieties of potatoes were planted in order to determine whether or not 2, 4, 5-T acted differently or had varying effects on different varieties. Each variety was sprayed with 75 ppm. of the sodium salt of 2, 4, 5-T during full bloom. This of course means that the sprays were, of necessity, applied to the various varieties on different dates. There were four replicates of treated and untreated in each variety. Untreated and treated plots were planted and analyzed as paired samples. These tests were harvested on the 20th of October, 1948 and placed in a 50° F. controlled storage on the 4th of November, 1948. Since the different varieties respond much differently to the same storage conditions the shrinkage is much different for the various varieties. Shrinkage and sprout weights were made at different dates for the various varieties. Chippewa and

TABLE 1.—*Effect of various concentrations of 2, 4, 5-T—on yield and storage sprouting of Houma potatoes. Treatment—ppm 2, 4, 5-T.*

Full Bloom E (ppm)	2 Wks. after Bloom M (ppm)	4 Wks. after Bloom L (ppm)	Yield Lbs. per Plot	Wt. of Spts. as Per cent of Orig. Tuber Wt.	Other Shke. as Per cent of Orig. Tuber Wt.
0	0	0	68.2	9.78	7.41
0	25	0	71.2	8.95	7.04
0	25	50	68.2	6.20*	6.40*
0	50	0	67.5	8.68	7.26
0	50	50	72.0	8.00	6.28*
0	50	100	67.5	6.71*	6.38*
0	100	0	77.1	8.28	7.86
0	100	100	63.2	7.29*	6.36*
0	100	200	64.2	5.43*	5.70*
25	0	0	71.6	9.55	6.86
25	25	0	68.2	6.02*	6.33*
25	25	50	68.6	5.87*	6.44*
25	50	0	66.9	6.30*	6.67
25	50	100	76.9	5.92*	6.48*
25	100	0	72.1	6.43*	6.47*
50	0	0	71.8	8.02	6.84
50	50	0	83.6	5.76*	6.27*
50	50	100	79.6	7.28*	6.44*
50	100	0	72.9	5.98*	6.52*
50	100	200	71.6	5.00*	5.76*
L.S.D.	.05		N.S.D.	1.87 2.49	.80 1.06

*Significant at .05 below check.

Katahdin were desprouted and weighed on the 2nd of March, 1949; Essex and Sebago, on the 23rd of March, 1949; and Green Mountain and Rural on the 2nd of April, 1949. Table 2, gives the results of this test.

Table 2 shows that the various varieties reacted differently to 2, 4, 5-T sprays. Essex and Chippewa showed very little effect but Green Mountain, Rural, Sebago, and Katahdin showed significant sprout reduction. There were no significant differences in yield among any treated and untreated plots within the same variety. Probably these sprouting differences would have been greater had a higher concentration of 2, 4, 5-T been used.

Prevention of Field Sprouting:

Early in the 1949 season growers began reporting that certain potato varieties, particularly Ontario and Katahdin, were sprouting in the ground. The exact cause for this condition is not known but it appears to be associated with a very dry period of hot weather for several weeks followed by a period of abundant moisture. In our 1949 experiments we had a small field of Houmas which had been planted for an experiment on 2, 4, 5-T applications. One-half of this field was sprayed with three applications of the sodium salt of 2, 4, 5-T The first application of 50 ppm was made during full bloom, and two additional applications of 100 ppm and 200 ppm were made two and four weeks later, respectively. The other one-half of the field was not treated. Otherwise the field was treated uniformly as far as cultural treatment was concerned. When our attention was called to this field sprouting condition we sought to determine the effect of the 2, 4, 5-T sprays on field sprouting. At harvest counts were made and we found that the 2, 4, 5-T sprayed potatoes showed no field sprouting whereas the part of the field that was not sprayed averaged ten to fifteen per cent field sprouting. From these observations it appears that there may be a real place for 2, 4, 5-T sprays when field sprouting is anticipated or is just starting.

1948 *Storage Experiments*:

Since 2, 4, 5-T had proven so much more effective as a field spray than had NAA we decided to compare these chemicals in storage. Several different salts and esters were tested and several methods of application were used. Results will be given for each method of application.

Dust Applications:

2.2 per cent dusts of several esters and salts of 2, 4, 5-T and NAA were made up and ten tuber samples of Houma potatoes were treated with these dusts. The dusts were applied by placing the tubers in kraft paper bags and sifting the dust on top of them, the bags were then closed with paper clips and shaken so the dust would become thoroughly distributed. Dust was applied at the rate of one gram of pure chemical to a bushel of tubers. Each treatment was replicated

TABLE 2.—*Effect of 75 ppm full bloom spray on storage, shrinkage, and sprouting of 6 potato varieties.*

Variety	Yield Lbs. per Plot			Wt. of Sprouts as Per cent Orig. Tuber Wt.			Other Shrinkage as Per cent Orig. Tuber Wt.			Date Desprouted
	Treated	Check	Odds	Treated	Control	Odds	Treated	Control	Odds	
Essex	52.2	52.8	1:1	8.14	7.83	1:1	7.09	6.85	5:1	3/23/49
Green Mt.	53.9	47.9	9:1	2.55	3.67	99:1	4.92	5.35	5:1	4/2/49
Sebago	41.8	42.1	1:1	3.40	4.09	127:1	7.55	7.52	1:1	3/23/49
Rural	44.9	45.6	1:1	1.61	2.57	99:1	4.92	5.08	3:1	4/2/49
Chippewa	50.5	54.9	2:1	3.93	4.55	11:1	5.86	5.85	1:1	3/2/49
Katahdin	48.1	49.0	1:1	2.13	3.10	99:1	4.21	4.38	6:1	3/2/49

ten times and placed in the 50° F controlled storage. Weights of sprouts and other shrinkage were taken on the 3rd of March, 1949.

Table 3 shows the results of this experiment. The isopropyl ester and the methyl ester of 2, 4, 5-T were as effective as MENA in inhibiting sprouting and reducing other shrinkage. There appears to be an indication, however, that MENA may be slightly better since it shows a lower per cent loss in all cases, although this difference is not significant at the .05 level.

TABLE 3.—*Effect of 2.2 per cent inhibitor dust on shrinkage and sprouting of Houma tubers.*

Treatment	*Wt. of Sprouts as Per cent of Orig. Tuber Wt.*	*Other Shrinkage as Per cent of Orig. Tuber Wt.*
1. Sodium Salt of 2, 4, 5-T	4.74	4.63
2. Isopropyl ester of 2, 4, 5-T	.55	3.77
3. MENA	.39	3.49
4. ME 2, 4, 5-T	.81	3.73
5. No treatment	6.24	4.89
L. S. D. .05	.98	.50
.01	1.34	.68

Immersion Applications:

From previous results it appeared that uniform coverage of the tubers might improve sprout inhibition so an experiment was designed to test this. Individual tubers were dipped into suspensions of the 2.2 per cent dusts. The dust was suspended in a solution of 3 parts ethyl alcohol and 1 part water at a concentration of 5000 ppm actual chemical. Treatments were replicated ten times. Tubers were treated on the 20th of December, 1948 and placed in the 50° F. controlled storage. Weights of sprouts and shrinkage were taken on the 4th of April, 1949.

Results of this experiment are shown in table 4. Table 4 shows that by this method of application the methyl and the isopropyl esters of 2, 4, 5-T are much more effective as a sprout inhibitor than is MENA.

Toothpick Injection Methods:

In order to determine the effect of the different inhibitors after they were inside the tubers we decided to test them by the toothpick injection method as described by Ellison (1948) and Smith, Ellison and Mc Goldrick (1949). Round polished toothpicks were soaked for two days in a suspension of the 2.2 per cent dusts in 3 parts of ethyl alcohol and 1 part of water. The concentration of actual chemical was equivalent to 5000 ppm. These toothpicks were then allowed to dry and stuck one-half their length into Houma tubers. Ten toothpicks were used per tuber. The treatments were replicated 10 times. Treat-

TABLE 4.—*Effect of suspensions of 2.2 per cent inhibiter dust on shrinkage and sprouting of Houma tubers in storage.*

Treatment	Wt. of Sprouts as Per Cent of Orig. Tuber Wt.	Other Shrinkage as Per Cent of Orig. Tuber Wt.
1. No treatment	6.66	7.12
2. MENA	4.27	4.94
3. ME 2, 4, 5-T	.20	4.10
4. I. E. 2, 4, 5-T	0	3.68
5. Na Salt 2, 4, 5-T	5.42	6.52
L. S. D. .05	2.57	1.03
.01	3.43	1.38

ments were made on the 23rd of December, 1948 and the tubers were placed in a 50° F. controlled storage immediately. Weights of sprouts and shrinkage were taken on the 5th of May, 1949.

Table 5 shows the results of this test. Here again the 2, 4, 5-T compounds seem to be more inhibitory than MENA. The sodium salt of 2, 4, 5-T was most effective. Ellison (1948) has shown that the sodium salt of NAA is as effective as is 2, 4, 5-T when injected by this method.

There is a possibility that other methods of application may prove 2, 4, 5-T even more effective. Experiments are now underway designed to test this possibility. Wax for instance is another medium which might be used to apply the inhibitor to the tubers.

TABLE 5.—*Effect of various sprout inhibitors injected into tubers on sprout growth and shrinkage in Houma tubers.*

Treatment	Wt of Sprouts as Per Cent of Orig. Tuber Wt.	Other Shrinkage as Per Cent of Orig. Tuber Wt.
1. No treatment	11.36	11.62
2. MENA	2.92	4.90
3. M.E. 2, 4, 5-T	.31	4.14
4. I. E. 2, 4, 5-T	.20	4.50
5. Na Salt 2, 4, 5-T	.02	4.40
L. S. D. .05	1.34	1.14
.01	1.79	1.52

SUMMARY AND CONCLUSION

Earlier work by Smith, Baeza and Ellison (1947) and Ellison (1949) has shown field applications of sprout inhibitors to be effective in reducing storage sprouting of potato tubers.

Experiments were conducted to determine optimum number, time, and concentrations of sprays.

Field applications of sprout inhibitors show promise as a means of reducing storage sprouting at rather high temperatures (50-60°F).

They do not, however, seem able to inhibit sprouting completely without severe injury to the tubers. It was found that the effect of sodium 2, 4, 5-T sprays varies with the variety and environmental conditions. Concentrations that may cause severe injury on one occasion and one variety may cause no damage at all during another season or when used on a different variety.

There is a possibility that the addition of sprout inhibitors in storage after field treatment with low concentrations that do not injure the vines or tubers may be very satisfactory.

It appears that 2, 4, 5-T sprays in the field will reduce field sprouting on some varieties during seasons when this is a problem.

Various sprout inhibitors show different degrees of activity in storage depending upon the methods used in applying them. In storage applications testing three forms of 2, 4, 5-T and MENA, the MENA was most effective in inhibiting sprouting as a dust, the isopropyl ester of 2, 4, 5-T was most effective as a suspension and the sodium salt of 2, 4, 5-T was most effective when injected into the tubers with toothpicks.

Further work should show the most effective means of inhibitor application and whether or not field sprays supplemented by storage treatment will be successful.

Experiments are being continued on further methods of field and storage application of sprout inhibitors to determine the optimum time, concentration and method of application.

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EFFECTS OF WATER SUBMERSION ON SEED VALUE OF POTATO TUBERS[1]

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Occasionally it is the unfortunate experience of growers of seed potatoes to find a portion of their stored crop submerged in water. This is most likely to happen during a period of excessive rainfall resulting in ground flooding in the spring when the water is cold. The question subsequently arises as to whether the submerged potatoes have been damaged for use either as seed or food. The author has no knowledge of any published work to determine the effect of water submersion on the value of seed potatoes as influenced by such factors as length of submersion period and temperature of the water. An experiment to provide concrete evidence which could be used as a basis for appraising possible damage, therefore, was set up in the spring of 1948. The objective of this paper is to report the results of two years' work during which seed tubers were submerged under controlled temperature conditions.

MATERIALS AND METHODS

Medium sized tubers of the varieties Katahdin and Sebago in dormant condition were used as test material. Beginning on the 27th of March, 1948, three tubers of each variety were weighed and submerged in tap water in two-gallon stone crocks, one tuber to each crock to provide triplicate samples One such set of six was placed in a 40° F. controlled temperature room, another set in an office room to provide room temperature approximating 70° F. This procedure was followed for ten consecutive days involving a total of 120 tubers in the water treatments. On the 6th of April all tubers were removed, weighed, dried on paper towels and placed in greenhouse flats for a sprouting test. Sprout condition was used as a measure of seed value, final examination being made on the 1st of May or twenty-four days after removal from the water treatment. A check lot of untreated tubers for comparison was held in the 40° F. room until time to begin the sprouting test, Gram scales were used for tuber weights to determine gain or loss resulting from the submersion treatments. India ink was used to mark each tuber for identification at the end of the experiment as shown in figures 1 and 2.

The same procedure and duplicate materials were used in the 1949 experiment except that another set of crocks was placed in a 50° F. controlled temperature room. The latter was provided in an attempt to approach the threshold time-temperature point at which sprout or tuber injury might occur. The 1949 experiment involved a total of 180 tubers of the same varieties.

[1]Paper No. 326, Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

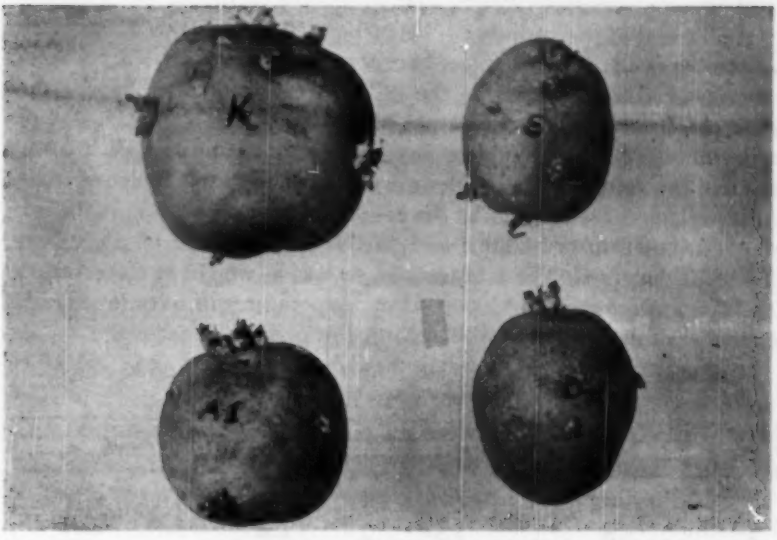

FIGURE 1. Upper — Katahdin (K) not treated; Sebago (S) not treated. Lower — Katahdin (A1) submerged 10 days at 40°, Sebago (D1) submerged 10 days at 40°

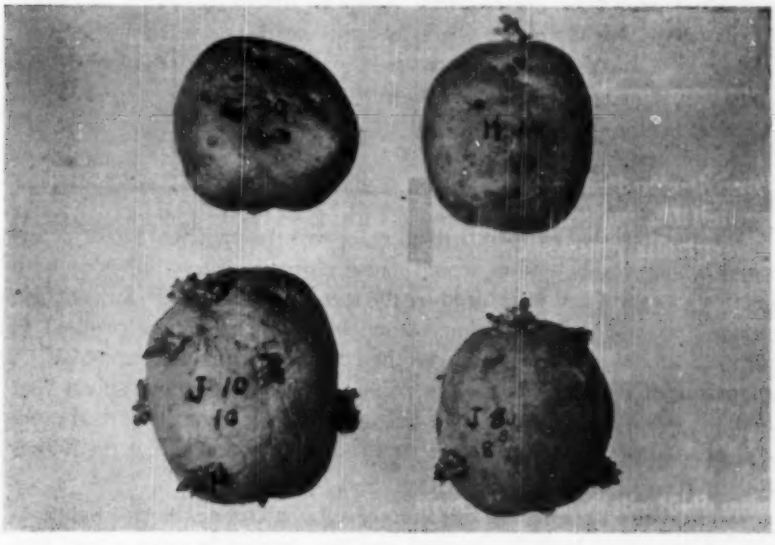

FIGURE 2. Upper — Katahdin (G10) submerged 24 hours at 70° F.; Katahdin (H10) submerged 24 hours at 70° F. Lower — Sebago (J10) submerged 24 hours at 70° F.; Sebago (J8) submerged 3 days at 70°F.

Results of 1948 Experiment

At the end of the 10th day of submersion, it was observed that froth was forming in all six crocks placed at room temperature (70° F.) whereas the water remained clear in the 40° F. treatments. Bubbling at the higher temperature indicated active fermentation and a breakdown of certain tubers. When the submersion period was terminated, each tuber was dried by blotting with a paper towel and immediately weighed. Any gain in weight is assumed to be the result of water absorption, although loss is attributed to breakdown and partial disintegration of the tubers while still submerged. The average gain or loss in weight of three tubers of each variety for each of the two water temperatures in accordance with the number of days submerged is recorded in percentage table 1.

Table 1. — *Average gain or loss in weight of tubers during submersion in 1948.*

Number Of Days Submerged	At 40° F. Water Temperature — Percent Weight Change		At 70° F. Water Temperature — Percent Weight Change	
	Katahdin	Sebago	Katahdin	Sebago
1	+ 0.12	+ 0.06	0.52	0.78
2	0.26	0.36	1.02	0.94
3	0.28	0.14	-0.31	0.64
4	0.26	0.15	0.59	0.71
5	0.40	0.29	-0.12	0.35
6	0.38	0.45	-0.65	-2.92
7	0.23	0.15	-5.00	-0.82
8	0.43	0.36	-2.91	-0.13
9	0.21	0.17	-3.15	-0.34
10	0.59	0.56	-2.30	1.08

It is obvious that temperature of water was the principal factor determining whether submersion would cause damage. Every tuber of both varieties was solid and uninjured by the treatments at 40° F. In contrast, fermentation and decomposition caused by bacterial action resulted in nearly all tubers submerged longer than five days in water at 70° F. A comparison of the two varieties in respect to weight changes shows that Katahdin was more sensitive than Sebago in that it either absorbed more water at the lower temperature or suffered greater damage at the higher temperature.

To measure the effect of duration of submersion at the two temperatures on sprouting both the treated and the check lots were placed topside up in single layers in greenhouse flats on the 6th of April for a greensprouting test. Final observation of conditions of tubers and sprouts

was made on the 1st of May, or twenty-five days after exposure for greening. All tubers showing flesh decay, dead eyes and no possibility of sprout development were immediately discarded.

Every tuber submerged at 40° F. regardless of duration of time or variety developed sprouts as numerous and as vigorous as those which were not treated. This is illustrated in figure 1. Quite in contrast, none of the tubers submerged more than five days at room temperature (70° F.) was sound or suitable for seed. Where damage was not sufficient to be evident as slimy rot, it was first evident as sunken decayed tissue at the lenticles. The only instance of survival of tubers submerged longer than four days at room temperature was tuber J-6 of the Sebago series submerged five days. All eyes with the exception of one produced vigorous sprouts, but this tuber developed a small area of slimy rot. Also the only surviving tuber of those submerged four days at 70° F. was of the Katahdin series. This one produced good sprouts at all eyes and the tuber was apparently sound. Assuming that a tuber which is sound has produced at least one vigorous sprout is usable for seed, the relation of number of days submerged at 70° F. to percentage survival in the 1948 experiment was for four, three, two and one days, 17, 50, 50, and 83 per cent, respectively. It is evident that submersion of potato tubers in water at 70° F. for so short a period as twenty-four hours may cause damage. This is evident in tubers G-10 and H-10 in the Katahdin series shown in figure 2. In contrast, some tubers may produce vigorous sprouts after a similar treatment for as long as three days as shown by Sebago tuber J-8 in figure 2.

Results of 1949 Experiment

The 1949 experiment was set up essentially the same as that of 1948 except that an additional set of treatments was placed in a 50° F. controlled temperature room. Later, a fourth set of treatments was arranged to include a 60° F. treatment and all water acidified to eliminate growth of bacteria.[1] The 1949 experiment was set up on the 11th of April and terminated on the 21st when the tubers were exposed for greensprouting. Twelve tubers of untreated check material of both varieties were held at 40°, 50° and 70° F. until time for the greensprouting test. The average gain or loss in weight of three tubers of each variety at each temperature and duration of treatment is shown in table 2.

The weight changes in 1949 were similar to those of 1948 but of a greater magnitude. Tuber weights increased slightly during the first three or four days as a result of water absorption at both the 40° and 50° temperatures. This increase ranged from 0.34 per cent to 2.38 per cent at the end of the ten-day submersion period, all tubers remaining solid.

[1] Professor C. N. Stark, Cornell bacteriologist, rendered advice and assistance in all phases pertaining to bacterial action.

At 70° F., all tubers submerged for more than three days lost weight and were partially or wholly disintegrated from bacterial putrefaction. Shrinkage in weight of the untreated lots for the ten-day period is shown in table 3.

TABLE 2.—*Average gain or loss in weight of submerged tubers in* 1949.

Number Of Days Submerged	At 40° F. Percent weight change		At 50° F. Percent Weight change		At 70° F. Percent Weight Change	
	Katahdin	Sebago	Katahdin	Sebago	Katahdin	Sebago
1	0.34	0.49	0.44	0.66	1.07	0.72
2	0.38	0.65	1.10	0.95	0.77	0.91
3	1.14	0.75	0.83	1.08	0.72	0.92
4	0.93	1.29	1.75	1.92	-0.37	-1.80
5	1.71	2.21	1.19	2.03	-1.84	-4.09
6	1.83	1.92	2.76	1.68	-5.49	-6.54
7	1.29	2.32	1.76	2.20	-9.23	-10.54
8	1.85	1.96	2.10	1.94	-9.44	-8.22
9	2.69	2.07	1.96	2.64	-14.20	-11.93
10	2.27	2.38	2.27	2.32	-25.24	-21.22

TABLE 3 — *Percentage loss in weight of check material* (10 *days*)

Variety	40° F.	50° F.	70° F.
Katahdin	0.32	0.47	1.70
Sebago	0.51	0.64	2.07

Shrinkage in weight of the unsubmerged tubers increased with temperature and was in each case greater for Sebago than for Katahdin.

An acidity test at the time the tubers were removed showed that all solutions were at approximately pH 7.0 except for Sebago at 70° which was pH 6.0. Bacteria from the solutions were plated on the 22nd of April. An examination showed them to be of the gram negative straight-rod type (stained pink). There were several million per drop of water of the 70° F. solution but only a few per drop of water of the lower temperatures.

All tubers still showing any solid eyes were also exposed for greensprouting on the 22nd of April. The only lot showing any sign of sprouting at this time was the untreated lot stored ten days at 70° F. A final examination of the greensprouted tubers was made on the 14th of May, or twenty-two days after exposure. Except for a single dead eye on each of two Katahdin tubers submerged ten days at 50°, all tubers submerged at 40° and 50° developed normal sprouts. At 70° every tuber submerged for a period longer than three days developed no sprouts and was wholly or partially decayed. Of those treated three days or less, there was none which produced healthy sprouts at every eye. Typical sprout character on each variety for ten days submersion at 40° and 50° and for two days at 70° is shown in figures 3 and 4. Submerged two days at 70°, the Katahdin tuber shows all eyes dead, the Sebago tuber showing approximately one-half normal sprouts.

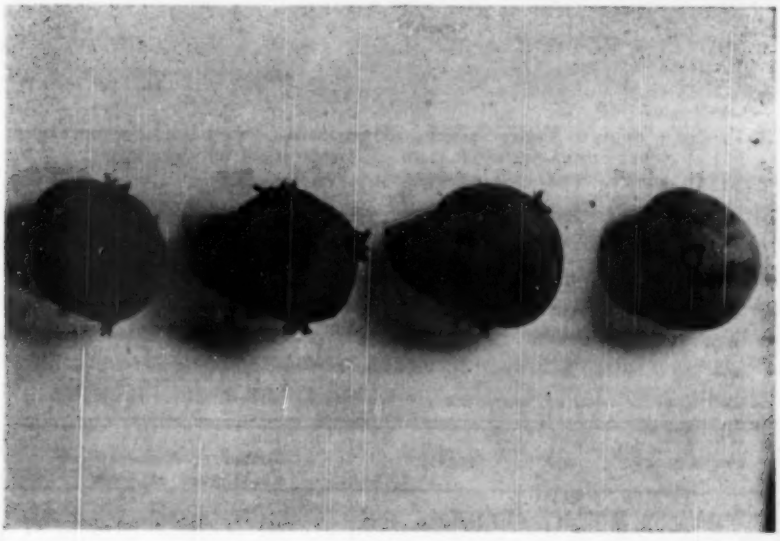

FIGURE 3. Katahdin Variety greensprouted twenty-two days. Treatments left to right: Stored untreated at 50° F.; submerged ten days at 40°F.; submerged ten days at 50°F.; submerged two days at 70° F.

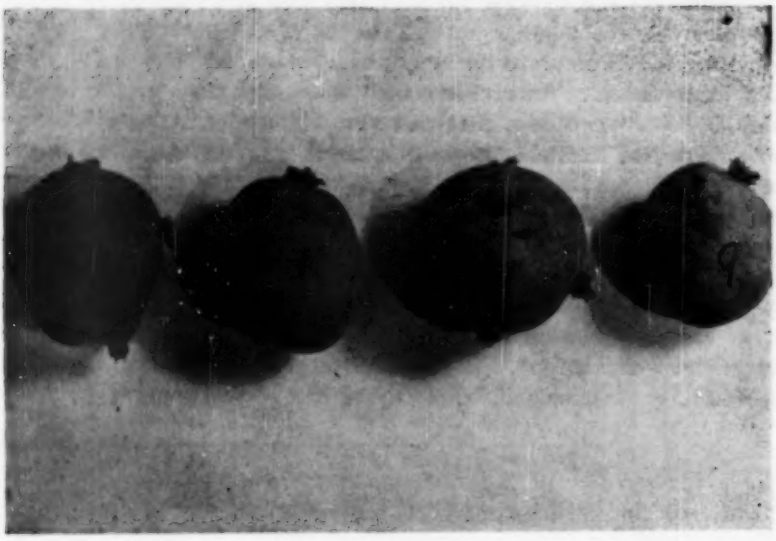

FIGURE 4. Sebago Variety greensprouted twenty-two days. Treatments left to right: Stored untreated at 50° F.; submerged ten days at 40° F.; submerged ten days at 50° F.; submerged two days at 70° F.

BACTERIAL ACTION IN RELATION TO ACIDITY AND TEMPERATURE

Frothing or bubbling of the water of the 70° F. treatments and partial decay of the tubers indicated that bacterial action was favored by the higher temperature. To test this assumption, cultures from the 40°, 50° and 70° solutions were plated in petri dishes and incubated. Counts of bacteria resulted as shown in table 4.

TABLE 4 — *Relation of temperature to number of bacteria in water treatments*

Temperature	Variety	Number of Bacteria per Milliliter of Water
40° F.	Katahdin	74,000
	Sebago	12,600
50° F.	Katahdin	510,000
	Sebago	4,500,000
70° F.	Katahdin	70,000,000
	Sebago	11,100,000

The data in table 4 show that bacterial counts, and therefore bacterial action, appear to be a function of temperature and may be presumed to explain why damage to seed tubers by water submersion depends largely on temperature.

Since it is possible to prevent bacterial growth by acidifying the culture medium, a preliminary test of this factor was set up on the 25th of April. Ten tubers, of Katahdin and Sebago varieties, respectively, were submerged in water in two-gallon crocks and placed for ten days at temperatures of 40°, 50°, 60° and 70°. The water was first acidified with acetic acid but to increase the acidity to approximately pH. 3.0 to 3.5, hydrochloric acid was added. After five days, some mold growth was observed in the 70° treatments but neither fermentation nor mold appeared at any lower temperature. On the ninth day, a few bubbles appeared in the water at room temperature. All tubers were dried and exposed for greensprouting after ten days in the acidified water. Although every tuber (total of 40) was solid when removed from the solution, after thirteen days of greening, all eyes were observed to be dead. the tissue around the lenticels sunken and decayed and the damage progressively worst at the higher temperatures. These results, therefore, point the need for further work to determine whether it is possible to acidify the submersion water sufficiently to prevent bacterial action without damaging the seed value of the submerged tubers.

Discussion and Conclusions

Flooding of seed potato storages for a few days in the spring is not uncommon. The grower who suffers this experience is likely to want to know immediately whether his seed has been damaged. Without resorting to a greensprouting test to determine possible damage, it should be possible to estimate in accordance with known conditions. Conditions affecting damage to submerged potato tubers may include duration of submergence and temperature, oxygen content and purity of the water. No attempt was made in this study to measure the influence of the oxygen supply of the water. On this factor, however, the conclusion reached by Platenius (1946) in respect to the pre-packaging of vegetables in pliofilm seems pertinent. He found that by the time the oxygen in the package is reduced from 21 to about 3 per cent, the rate of respiration is cut in half. At this point, respiration shifts from aerobic to anaerobic. With no more free oxygen entering the reaction, carbohydrates are oxidized to alcohol and carbon dioxide. This makes it appear that stagnant water or water of very low oxygen content would be more likely to damage submerged potato tubers than would well-aerated water. Smith and Ramsey (1947) have found that bacterial soft rot, originating at the lenticels, is the most common cause of decay in potatoes arriving on the Chicago market during the past four years. These authors readily obtained lenticel infections in the freshly harvested potatoes by immersing them for one minute or longer in water suspensions of bac-

teria isolated from lenticels. At the higher humidities, infection occurred at 61° F. but decay was more rapid at 72° F. They also found that when drying occurs in the infected area around the lenticels, the epidermis often becomes slightly sunken, although it generally remains intact. Cross sections through such lenticels reveal that the outer periderm and the infected parenchyma have become separated — resulting in a small cavity between them. These findings seem to substantiate the results of this study in that decay was always first evident as sunken and decayed tissue around the lenticels and became progressively worse with the higher temperature.

Dormant tubers of both Katahdin and Sebago varieties of potatoes were submerged in water daily for ten days at temperatures of 40°, 50° and 70° and subsequently given the greensprouting test to determine any possible damage to their seed value. Normal, vigorous sprouts developed at all eyes on tubers submerged as long as ten days at temperatures of 40° and 50°. At 70° or room temperature, dead eyes and sunken, decayed lenticels were very generally present on tubers submerged more than three or four days. This damage is ascribed mainly to the fact that bacterial action was favored by the higher temperature. In appraising possible damage to tubers subject to flooding, it appears that temperature of the water should be the first consideration. The exact threshold temperature was not determined but it is apparently between 55° and 65° Fahrenheit.

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RECENT PROGRESS IN THE CONTROL OF WIREWORMS ON POTATOES

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Wireworm control has presented many difficult problems to its investigators. The wheat wireworm, *Agiotes mancus* (Say), was effectively controlled by cultural methods, but these methods were ineffective against the eastern field wireworm, *Limonius agenus* (Say). Cultural control methods, even when they were effective, were not always popular with many potato growers who often found them inconvenient or impractical. Soil fumigants, although effective, were too expensive for general usage .

Benzene hexachloride's introduction, during the war years, reopened investigation into the use of soil insecticides. This insecticide was found to be a very effective method of control when applied to infested soils, but the serious problem of flavor contamination arose and potatoes were found to be very susceptible. Fortunately many new organic insecticides have been developed since this time and these materials may provide a safe, economical, and effective method of control.

The potentialities of benzene hexachloride as an insecticide were first shown by Slade (1945). Preliminary reports, published by Golightly (1946), Thomas *et al.* (1946), and Dunn *et al.* (1946), showed that an application of less than 1 pound of gamma isomer benzene hexachloride per acre gave a 60-70 per cent reduction in the wireworm population in fields of cereal grains. Jameson *et al.* (1947) found that over a 3-year period (1944-46) benzene hexachloride gave better control of wireworms on wheat than DDT did. Treatments broadcast on the soil previous to planting were found to be as good as or better than seed drilled with an insecticide and fertilizer combination or when the seed is treated previous to planting. Fall applications gave good protection to spring plantings of oats. Greenwood (1947) and Pepper *et al.* (1947) obtained effective control of wireworms attacking potatoes by treating the soil with benzene hexachloride. In the meantime, Kearns *et al.* (1945) tested a new insecticide, chlordane, and found it quite toxic to numerous insects. In 1947 Greenwood (1948) included chlordane and toxaphene with benzene hexachloride in his tests on potatoes and tobacco. On a basis of total injury, these materials gave rather poor control but on a basis of off-grade tubers, chlordane and benzene hexachloride gave good control while toxaphene gave very poor control. Pepper *et al.* (1949) found that there was no difference in the degree of control obtained from

the fall or spring applications of benzene hexachloride. Smith (1948), testing the persistence of DDT and benzene hexachloride in soils, found that 80 per cent of the benzene hexachloride could be recovered after the soil had weathered for 18 months. The toxic quality of the soil at this time was not particularly impaired.

O'Kane (1947), working with various crops, found that potatoes were susceptible to off-flavor contamination when treated with benzene hexachloride. Arnason *et al*, (1917) found benzene hexachloride imparted an off-flavor for two years after the soil had been treated. Pepper *et al.* (1949) found that crude benzene hexachloride imparted a very distinct off-flavor when applied the same year as tested. Refined and pure gamma isomer benzene hexachloride were not as objectionable. Chlordane was found to give an off-flavor but there was no breakdown of the responses obtained at the various concentration levels used.

Treatments

Soil insecticides were tested during the 1947, 1948, and 1949 seasons in Upstate New York potato fields which were infested with either the eastern field wireworm or the wheat wireworm. Two insecticides were tested in 1947; chlordane at 2, 4, 8, and 16 pounds per acre, and crude benzene hexachloride at 0.125, 0.25, 0.5, 1.0 and 2.0 pounds of gamma isomer per acre. Five insecticides were tested in 1948; crude and refined grades of benzene hexachloride at 0.5, 1.0, and 2.0 pounds of gamma isomer per acre, chlordane at 2, 4, and 8 pounds per acre, heptachlor (1) at 0.5, 1.0, 2.0, 4.0, and 8.0 pounds per acre, and compound 118 (2) at 2, and 4 pounds per acre. In 1949 five insecticides were tested; chlordane and compound 118 at 4, 6, and 8 pounds per acre; heptachlor at 2, 4, and 6 pounds per acre; compound 497 (3) at 2, 4, 6, and 8 pounds per acre; and refined benzene hexachloride at 1 pound of gamma isomer per acre. Tuber injury records were made in 1949 on two experiments treated in 1948.

Experimental Methods

Insecticide treatments were applied, in the spring, to the surface of soil previously fitted. They were diluted with either pyrophyllite or talc, the latter being used in 1947 only, as its physical properties were not suited to the applicators used in these tests. Broadcast applications of the diluted insecticides were made with a small hand fertilizer dis-

[1]Heptachlor, or compound 104—1, (or 3a), 4, 5, 6, 7, 8, 8, heptachloro—3a, 4, 7, 7a—tetrahydro—4, 7—methanoindene.

[2]Compound 118—1, 2, 3, 4, 10, 10-hexachloro—1:4, 5:8 diendomethano—1, 4, 4a, 5, 8, 8a-hexadydronaphthalene, technical grade.

[3]Compound 497—1, 2, 3, 4, 10, 10-hexachloro-6, 7,-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a, octahydro-1, 4, 5, 8-dimethanonapthalene. Technical grade.

tributor and the land harrowed or disced two or three times to insure thorough mixing of the insecticides in the top four or five inches of soil.

Treatments were replicated three or four times in randomized blocks. The plots were either 0.01 or 0.02 acres in area.

Wireworm injury counts were made on 100 tubers from each plot. The tuber samples were dug by hand from the center four rows of each plot and washed to facilitate inspection. Injured tubers were placed in three categories; slight having one feeding puncture, moderate two to five, and severe six or more. Punctures less than 0.25 inches in depth were not recorded and any questionable injury was considered to be caused by means other than wireworms. The injury is recorded in the tables of results as total injury and moderate plus severe. The moderate plus severe category closely approximates those tubers that would not make the U. S. number 1 grade.

Results

The results of the 1947 field experiments are given in table 1*. The wireworm injury in the untreated plots during this season was not

Table 1 — *Field results of wireworm control experiments on potatoes*, 1947

Treatment	Lbs. per Acre	Per Cent Wireworm Injury to Potato Tubers							
		Exp. 1		Exp. 2		Exp. 3		Exp. 4	
		Total	Mod. + Sev.		Sev. + Mod.	Total	Mod. + Sev.	Total	Mod. + Sev.
Untreated		36.2	16.3	32.1	13.2	31.5	18.0	33.0	16.8
Gamma crude benzene hexachloride	0.125	18.8	7.0						
	0.25	10.0	3.5	14.7	5.3	12.0	5.0		
	0.5	5.3	1.0	6.7	2.3	3.0	1.0		
	1	2.5	0.5	2.3	1.3	1.0	0.0		
	2	0.0	0.0	0.0	0.0	1.0	0.0		
Chlordan	2							4.8	0.8
	4			3.7	0.3	4.0	0.0	1.5	0.3
	8			2.0	0.7	3.0	1.0	1.3	0.5
	16			2.0	0.3			1.3	0.5
Least significant difference	19:1	4.5		10.2				9.5	
	39:1	6.2		13.8				15.7	

Experiment 1 Penfield, N. Y., Ontario loam, Eastern field wireworm.
Experiment 2 Potter, N. Y., Organic soil, Wheat wireworm.
Experiment 3 Cohocton, N. Y., Mardin gravelly silt loam, Wheat wireworm.
Experiment 4 Spencerport, N. Y., Ontario fine sandy loam, Eastern field wireworm.

*These results previously published in Jour. Econ. Ent. 42: 326-329, 1949.

as heavy as desired. Applications of 0.125, and 0.25 pounds of gamma isomer crude benzene hexachloride per acre did not give effective control and were dropped from th 1948 tests. The 2-pound application of gamma isomer of crude benzene hexachloride was probab.ly an excessive rate of application. All concentrations of chlordane gave satisfactory control in 1947. The application of 16 pounds of chlordane per acre was not used in future tests as there was no significant difference in control between the 8 and 16-pound applications.

The results of three of the 1948 experiments are presented in table 2*. The wireworm injury in the untreated plots was rather heavy. Chlor-

TABLE 2 — *Field results of wireworm control experiments on potatoes, 1948*

Treatment	Lbs. per Acre	Per Cent Wireworm Injury to Potato Tubers					
		Exp. 1		Exp. 2		Exp. 3	
		Total	Mod. + Sev.	Total	Mod. + Sev.	Total	Mod. + Sev.
Untreated		53.3	33.0	66.9	51.4	33.7	16.7
Chlordan	2	19.3	12.3	15.5	6.2	9.3	3.3
	4	15.3	8.0	5.1	3.3	8.0	2.0
	8	6.0	3.0	2.0	0.4	3.7	1.0
Hepta-chlor	0.5			11.2	5.1		
	1	12.7	6.3	2.7	0.7		
	2	4.0	1.7	1.5	1.2	4.7	2.3
	4	5.3	2.0			4.3	0.0
	8	0.3	0.0			1.7	0.7
Compound 118	2	16.7	9.0				
	4	3.7	1.3			2.7	0.7
Least significant difference	19:1	11.8		6.5		7.5	
	99:1	16:1		8.8		10.4	

Experiment 1. Ithaca, N. Y., Canfield silt loam, Wheat Wireworm.
Experiment 2. Medina, N. Y., Berrien fine loamy sand, Eastern field Wireworm.
Experiment 3. Penfield, N Y., Genesee fine sandy loam, Eastern field Wireworm.

dane did not give as effective control in 1948 as in 1947. This was most pronounced in the 4 pound application. Heptachlor, a new insecticide, at concentrations of 0.5 and 1.0 pounds per acre was not entirely satisfactory and they were dropped from further tests. The higher concentrations of this material gave good control. Compound 118, also a new insecticide, gave good control at 4 pounds per acre. This material was tested at only two concentrations as there was an inadequate supply of it at this time.

*These results previously published in Jour. Econ. Ent. 42: 326-329, 1949.

TABLE 3 — *Field results of wireworm control experiments on potatoes 1948, and 1949*

Treatment	Lbs. per Acre	Per Cent Wireworm Injury to Potato Tubers							
		Exp. 1				Exp. 2			
		1948		1949		1948		1949	
		Total	Mod. + Sev.	Total	Mod. + Sev.	Total	Mod. + Sev.	Total	Mod. + Sev.
Untreated		28.8	15.3	26.0	12.3	44.3	29.8	47.5	30.5
Gamma crude benzene hexachloride	0.5	1.8	0.5	7.8	4.0				
	1.0	1.0	0.5	0.8	0.3				
	2.0	0.3	0.3	1.5	1.0				
Gamma refined benzene hexachloride	0.5	3.3	0.3	2.8	0.5				
	1.0	4.8	0.8	3.3	1.5	31.5	21.3	25.0	1.5
	2.0	1.0	0.0	1.0	0.5	3.8	1.3	5.8	1.5
Chlordan	2.0	3.0	1.0	5.5	4.0	14.0	7.8	21.0	11.8
	4.0	1.8	0.3	1.5	0.5	10.8	5.3	9.3	2.8
	8.0	1.3	0.3	0.8	0.8	2.5	0.8	8.0	2.3
Least significant difference	19:1	4.2		5.0		21.8		17.0	
	99:1	5.7		6.8		29.7		23.0	

The results of the two other tests carried on in 1948 are given in table 3. Tuber injury was also recorded in 1949, treatments made in Spring of 1948 only, to determine the residual toxicity of these materials over an extended period. The 1949 results are paired with their 1948 counterparts in table 3. In experiment 1 all concentrations of insecticides used gave good control in 1948. Crude benzene hexachloride at 0.5 pound of gamma isomer per acre was the only treatment that showed a marked increase in tuber injury in 1949. In experiment 2 refined benzene hexachloride at 1 pound of gamma isomer per acre gave very poor control in 1948, but there was a very slight increase in effectiveness in 1949. Chlordane at 2 and 4 pounds per acre was not as effective as in 1947. The 2 pounds of chlordane were slightly less effective in 1949 than in 1948.

The results of the 1949 field experiments are given in table 4. Chlordane, at all concentrations, did not give the degree of control experienced in the previous two years. Heptachlor and compound 118 gave good control at all levels of concentration tested. Compound 497, introduced experimentally in 1949, gave comparable results.

TABLE 4 — *Field results of wireworm control experiments on potatoes, 1949*

Treatment	Lbs. per Acre	Per Cent Wireworm Injury to Potato Tubers					
		Exp. 1		Exp. 2		Exp. 3	
		Total	Mod. + Sev.	Total	Mod. + Sev.	Total	Sev. + Mod.
Untreated		29.7	12.7	40.3	26.5	49.7	29.3
Chlordan	4			11.5	4.8	19.7	9.3
	6	5.0	2.7	11.5	3.3	7.7	2.7
	8			7.0	2.0	6.0	2.3
Heptachlor	2	3.7	1.7	5.0	1.8	2.3	0.7
	4	1.0	0.7	1.8	0.3	2.3	0.7
	6			3.0	0.7	1.7	0.3
Compound 118	4	3.0	1.7	5.3	1.0	2.7	1.0
	6	1.7	0.0	3.5	1.0	4.3	2.3
	8	2.3	0.0	4.5	0.8	3.0	1.3
Compound 497	2			3.3	0.5		
	4	8.7	3.7	3.3	0.8	2.0	0.7
	6	2.3	0.3	2.0	0.5	2.3	0.7
	8	0.0	0.0	0.8	0.3	2.3	0.7
Gamma refined benzene hexachloride	1					5.7	2.3
Least significant difference	19:1	9.3		7.7		6.2	
	99:1	12.7		10.4		8.3	

Experiment 1 Ithaca, N.Y. Canfield silt loam, Wheat wireworm
Experiment 2 Indian Falls, N.Y. Dunkirk fine sandy loam, Eastern field wireworm
Experiment 3 Center Village, N.Y. Chenango gravelly loam broken phase Wheat wireworm.

DISCUSSION

The insecticides tested showed a high degree of toxicity to wireworms. Benzene hexachloride—crude and refined grades—gave practical control at 0.5 to 1.0 pounds of gamma isomer per acre. The failure of 1.0 pound of gamma refined benzene hexachloride to give control in one experiment may indicate that at this concentration level it is ineffective under certain conditions, whatever these may be.

Chlordane, at all concentration levels tested, gave very promising results in 1947. In 1948, the 4-pound application was not too effective when the wireworm infestation was relatively heavy. A 6-pound application was included in the 1949 tests in the hope that under relatively

heavy insect infestations it would give adequate control. Unfortunately all rates of application tested in 1949 gave poorer results than experienced in other seasons. On a basis of off-grade potato tubers (approximately the moderate plus severe category) the control obtained is actually not unsatisfactory nor impractical.

The degree of control obtained with benzene hexachloride and chlordane, one year after treatments are applied, is encouraging. The 0.5 pound application of crude benzene hexachloride was the only treatment tested where there was a material decrease in control effectiveness in the following season. On the other hand, the 1-pound application of refined benzene hexachloride in experiment 2 responded with a slight decrease in the per cent of tubers injured in 1949 as compared to the previous year. The crucial test of residual toxicity for these insecticides will be in 1950, when the larvae hatched in 1949 will be large enough to do noticeable damage to the potato tubers.

The newer insecticides, heptachlor, compound 118, and compound 497 have all shown most promising results. Heptachlor gave satisfactory control at the 2 to 4-pound level, and 4 pounds of compound 118 gave comparable results. Both these insecticides appear to give more effective control than chlordane. Compound 497 appears to be as effective as compound 118, but will require more investigation.

Flavor contamination of potato tubers is the largest limiting factor to the use of any of these soil insecticides. Results of flavor tests, run in conjunction with these control tests, have not been presented here as they have not been tested thoroughly enough. Off-flavor and sometimes off-odors have been found in the cooked potatoes, and some of the contamination has been so objectionable that these tubers could not be consumed. Benzene hexachloride is particularly offensive in this respect, although some of the other materials appear more promising. The effects of soil type, concentration of the material used, their persistence in the soil, length of storage of tubers, and the method of cooking, on the flavor of potato tubers must all be thoroughly investigated before any of these materials can be considered safe for commercial use.

Summary

Six soil insecticides, crude and refined benzene hexachloride, chlordan, compound 118, heptachlor, and compound 497 were tested against wireworms on potatoes during a 3-year period.

Benzene hexachloride—crude and refined grades—gave practical control with applications of 0.5 to 1.0 pounds of gamma isomer per acre. In one experiment, 1 pound of gamma isomer refined benzene hexachloride gave very poor control, indicating that under some conditions, whatever they may be, this rate of application is unsatisfactory.

Chlordane gave results which varied from year to year. Practical control can probably be obtained at the 4 to 6 pound level. Little change in effectiveness of these two insecticides was observed the year following the application of treatments. Heptachlor gave good control at the 2 to 4-pound level, and 4 pounds of compound 118 gave comparable results. Both these insecticides appear to give more effective control than chlordane. Compound 497 appears to be as effective as compound 118 but this material requires much more investigation.

Off-flavor to the potato tubers caused by these soil insecticides is the largest factor that limits their use. Results of flavor tests are not given as they have not been tested thoroughly enough. Off-flavor is imparted to cooked potatoes by the insecticides used. Benzene hexachloride was bad in this respect, but some of the other materials show decided pomise. A considerable amount of investigation into flavor contamination of tubers must be completed before any of these materials can be considered safe for commercial use.

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DR. EUGENE S. SCHULTZ HONORED BY THE POTATO ASSOCIATION OF AMERICA

Dr. Eugene S. Schultz, A Principal Pathologist in the United States Department of Agriculture, was elected an honorary member of the Potato Association of America at its annual meeting in Kansas City on December 8, 1949. This is an honor he justly deserves, after having served the potato industry of America well for nearly 40 years.

His early education was obtained in the country school at East Greenville, Pennsylvania. On his graduation from Perkiomen Seminary he decided to study plant diseases, and went to the University of Wisconsin where he studied under the able guidance of Professor L. R. Jones. It was Jones who first taught him how to isolate the late blight fungus and other pathogens of the potato. He obtained his Bachelor and Master of Science degrees in plant pathology from the University of Wisconsin in 1913 and 1915 respectively.

He studied for his doctorate degree at Columbia University under the eminent mycologist, Dr. R. A. Harper. His training while at Columbia was in cytology. Studies in nuclear division and spore formation in the fungi apparently were too "highbrow" and impractical to appeal to Dr. Schultz. Although his doctorate dissertation dealt with the cytology of a certain fungus, he has devoted most of his studies to the control of the diseases of the lowly potato.

He was reared on a farm in Palm, Pennsylvania. This early training has greatly influenced his life and he still loves to observe good farming practices and be with the soil. He likes to relate how he picked rocks on the hillsides of his home farm while a boy, and it probably was this early association which has made the rocky fields of Aroostook County, Maine, so enticing to him. He first came to Aroostook County about 1912 and since then has spent every summer among the potato fields of this area.

During this period he studied numerous phases of potato disease control and published many papers dealing with this problem. He has a bibliography of about 50 titles. A few of the potato fungus diseases included in his investigations are Powdery Scab (sometimes humorously referred to as "political" scab), Phoma Tuber Rot, Silver Scurf, Verticillium Wilt, Blackleg, Rhizoctonia and Late Blight.

He also has contributed much to our knowledge of the different potato virus diseases and their control. His collection of potato virus diseases which he has maintained for many years, has been helpful to many students. He and Dr. Donald Folsom of the Maine Agricultural Experiment Station were the first to demonstrate the role of aphids in the transmission and dissemination of potato mosaic, leafroll and spindle

tuber. They demonstrated that there are different kinds of potato mosaic diseases and that spindle tuber is a kind of virus disease. They also showed that net necrosis is a tuber symptom resulting from leaf-roll infection in certain potato varieties.

In recent years in cooperation with Dr. F. J. Stevenson and others, he has devoted his efforts to the development of varieties of potatoes that are resistent to the different virus and fungus diseases, as well as to studies of the nature of this disease resistance. The graft reaction of Virus X to resistant varieties and the development of varieties that are immune to Virus X, resulting from this work, are of outstanding importance to the potato industry throughout the entire world.

Gardening is his chief recreation and he has been interested in testing new varieties of vegetables for Aroostock County, Maine. He is especially interested in finding varieties of tomatoes, sweet corn and water melons which will mature in the vigorous climate of this northern area. Occasionally he fishes for trout in the local streams. In the past, he and Dr. I. E. Melhus (formerly of Iowa) took their "shootin' irons" and hunted for partridge in the country about Ashland.

Dr. Schultz is an extremely busy man, and the days are not long enough for him to accomplish the numerous tasks and problems he has undertaken. In spite of this, he is always cheerful and ready to give assistance and offer suggestions to his associates and farmers of Maine. A group of business men and farmers recently showed their appreciation by having him as their principal speaker at their annual banquet and honoring him for his many years of service in the interest of the potato industry.—REINER BONDE.

DR. DONALD REDDICK CITED

The Potato Association of America is indeed fortunate in having Dr. Donald Reddick, Professor of Plant Pathology, Cornell University, as one of its members of long standing. His interest in botanical science was early manifested as a student at Wabash College from which he graduated in 1905. This interest led him into the then new field of Plant Pathology as a graduate student at Cornell University. Receiving the Ph.D. degree from this institution in 1909, Dr. Reddick has remained at Cornell University carrying on his researches.

At an early date he showed great interest in the phenomena of disease resistances in various plants. His studies of the past 25 years on the potato late blight *Phytophthora infestans* and development of potato varieties resistant to its infection, have been of utmost importance to this Association and the potato growing industry. Early in his investigations he realized that to obtain late blight resistance it would be necessary to go back to the wild species of Solanum for parent stock. This was not an easy undertaking, but with characteristic thoroughness a wide collection of foreign and domestic varieties and wild species of Solanum was made. Through untiring efforts, potato hybrids having *Solanum demissum* as one parent were developed and high resistance to potato late blight infection was achieved. Results of these investigations comprising many scientific papers published by Dr. Reddick and his associates in the Journal of this Association and elsewhere have stimulated similar researches by other investigators.

His efforts along these lines have resulted in the development of late blight resistant hybrid varieties such as Placid, Virgil, Essex, Chenango and others. Although certain of these resistant varieties are of major importance in local areas of New York State, others are being produced under certification for out-of-state distribution among seed growers and all are of great value to the potato industry in its research program on disease resistance.

It seems particularly fitting that the Potato Association of America should confer upon Dr. Donald Reddick the Honorary Life Membership of the Association in recognition of his outstanding research contributions to the potato industry.—J. H. MUNCIE.

SECTIONAL NOTES

Alabama

Alabama has a nice potato crop on the way. This season has been so different from the normal that almost anything has happened. We planted during a summer-like condition with less than adequate soil water on hand and somewhat earlier than usual. Although we expected a lot of dry rot and fertilizer burning the contrary has been the case. Our stands are very good and, in general, our plants show normal or better than normal development. The weather has been very unusual especially during March. We have had temperatures below 30 degrees nearly every week during the month. Even as late as the 30th of March, the worse damage was done to some fields that had received cultivation during the last 48 hours before the low temperatures on that date. The over-all prospect seems to be very good in my judgment.

Late Blight was found as early as the 25th of March but so far no general bad spots have shown up. Our larger growers have gone out with a spray program of Parzate and Dithane. A few large growers and many of our smaller growers are dusting better than ever before and have started earlier. From our past experience, we expect Late Blight to be severe but the result of our control program will retard its damage until it will be slight. There will always be a few smaller farmers who, for one reason or another, will not apply dusts or sprays and will suffer reduced yields. Our chief objective this year, aside from yields, will be to hold the crop so that it can be marketel over a longer period. The 2-inch minimum we hear so much about might have something to do with better efforts among our growers.

The job done by our farmers, in giving better drainage to fields and better cultivation, especially by hilling the potatoes so that they will not stand in water in event of heavy rains, has been outstanding. A second application of fertilizer was applied to many fields and so far first time fertilizer containing approximately 40 pounds of Magnesium Oxide was used on more than one half of our crop. Some growers had their fertilizer made up with Tankage and Cotton Seed Meal as about half the source of nitrogen to prevent, as they think, the lack of nitrogen which occurs late in the growing season, particularly after heavy rains.

It is difficult to say at this time just how waxing will effect our deal. Some of our shippers probably will try it to some extent, as they usually try anything new, but we expect the bulk of our crop to move as usual—washed only. It can be concluded that our shippers are thinking in terms of a better pack to hold our market after we get started. Our Sebago shipments will be particularly the best pack we will ship.
—Frank E. Garrett.

Indiana

The potato situation in Indiana is very quiet. Practically every one was waiting to see and is still waiting to find out what the Government is going to do. Growers, other than the individuals who have been in this game for a number of years, will plant about the same acreage, the same varieties, and handle their crop in their usual manner. I do not believe that we will have much more than 20,000 acres planted to commercial potatoes in Indiana this year, and the consumer is very much "fed up" on the past history of destroying a very profitable crop in order to uphold the price. The per capita consumption has dropped considerably since this episode has taken place, and if we are not careful the entire business will be ruined.—W. B. Ward.

Nebraska

The potato situation in Nebraska in common with many other areas of the United States is rather confusing at this time. The surplus remaining in storage and yet to be marketed is approximately 1600 cars, which is considered in excess of the market needs at this date. Generally, the condition of the potatoes in storage is good, that is, sprouting is negligible or lacking in most cases.

The chief difficulty lies in the fact that the market has been depressed for several weeks, with very little demand and low prices for seed or table stock. Many growers who did not have Government support show reluctance to sell, hoping for an upturn in the market. If any great number should decide to sell, as they may need to one of these days, it may further depress the market.

The shipment of certified seed into southern territories has practically ceased. The movement of seed potatoes this past winter has been fairly satisfactory with only a small quantity left to be shipped. Growers of certified seed seemed fairly well pleased with the prices received, and indicate that they will plant approximately the same as last year. Sales of Foundation seed locally have been good for this time of the year, indicating that potato growers are changing to better quality seed, and planning to maintain about the same acreage.

It has been estimated that 15 to 20 per cent of the growers in this area were eligible for Government support this season. When marketing conditions looked favorable in the fall, some of the growers failed to comply, which naturally reduced the number of acres eligible for support. The Government has been accepting potatoes for some time, and most of the stock taken under the Government program is absorbed locally by live stock feeders, or is going to Government agencies for human consumption. To our knowledge, no potatoes have been destroyed.

The consideration of marketing agreements has found little favor among Nebraska growers in the past. Although there seems to be somewhat more of a trend in support of the marketing agreement, the actual outcome of voting is problematical. The general reaction to the potato program has been more adverse than favorable, as nearly as we can determine at this time.—MARX KOEHNKE.

NEW JERSEY

The potato growers of New Jersey, in a referendum held during the week of March 4-11, approved a marketing agreement under which all New Jersey potatoes will be sold in 1950. This program was designed to improve the grade and quality of the potatoes offered for sale and was voted for by 74.9 per cent of the growers voting and 76.1 per cent of the production represented. This is well over the ⅔ majority required for adoption of the agreement. Over 800 commercial potato growers voted in the referendum.

This vote will pave the way for the setting up of a committee of 8 growers and 4 dealers who will have authority to set up standards of grade, on size and other quality factors. The growers will also be eligible for price support for the 1950 season.

There are some indications that the acreage in New Jersey will be somewhat reduced because the allotments of some growers were too small to be cared for economically. Then, too, there are some growers who do not believe that the year 1950 will be a profitable one to grow potatoes and these growers, therefore, are not planning to plant any potatoes this year.

The support price to be in effect this season ranges from $1.55 per cwt, in July and August to $1.95 in December and $2.10 in March. This is approximately 20c per sack less than the 1949 price.

Practically all planting is finished but the cool weather has delayed germination.—JOHN C. CAMPBELL.

NEW YORK

Long Island held a Marketing Agreement hearing February 27-28 and March 1 and 2. There seemed to be much confusion in the minds of producers between Marketing Agreements and Support Programs and since the two are related it makes it rather difficult to explain.

Up-state New York may have a hearing during the next two months. Marketing Agreement Committees are at present trying to work out terms and conditions that might work in our territory.

Many growers, however, are very strong in their statements that they would rather not have any program than to be tied up by so many regulations and would feel that the sooner the potato business gets back

on its own the better it will be for all concerned. There is a strong indication that the acreage will be materially cut this year regardless of programs or other arrangements. Seed sales are very slow because of the unsettled condition in the minds of the growers. Supplies of Certified seed in up-state New York are low however, despite the slowness of movement because of so much oversize which was disposed of by marketing through regular channels. One grower reported 60 per cent oversize which would not have been profitable to grade out for seed. Local markets plus the cow feed disposal of surplus potatoes is taking care of the crop about as fast as it is offered. There may be a few more potatoes than is normal at this time of year, but there will be no burdensome surplus if present plans continue.—H. J. EVANS

OREGON

Due to uncertainty on individual farm goals with drastic cuts prescribed and legislation now in progress with the possibility of marketing quotas or other restrictions, the movement of certified seed potatoes has been rather slow to date. Large size certified and foundation seed has been marketed commercially and quite a bit of the stock left is six ounces and under. The quality of local seed this year is excellent, and all of it should be used in producing this year's crop.

The commercial market is in a chaotic condition with the price slipping slowly but surely throughout the season from digging time to the present. The future is not hopeful. Some support buying is underway but to date only small 1's and 2's have been bought. General buying may be necessary in the near future. Prices have dropped about 1/3 since harvesting. Further acreage reduction will be in effect in this district, perhaps aggregating 8 to 10 per cent for 1950.

Growers are uncertain and not hopeful regarding the outlook, in general. Sentiment is favorable to marketing agreement such as is in effect in this area. Most growers feel that supporting the general price level is not sound; and they are, also, dubious of marketing quotas. I believe the general feeling is that marketing agreement, with restricted acreage, offers the best possibility of again putting the potato industry on a sound footing.—C. A. HENDERSON

PRINCE EDWARD ISLAND

Until the present time growers of this Province have shattered all records in their shipment of seed and table potatoes. The demand is still heavy, particularly for our seed, although prices are very low.

There is a possibility we may still have a surplus, and some growers are pressing for a support program, whereas others, possibly influenced

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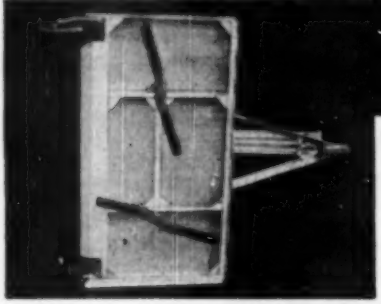

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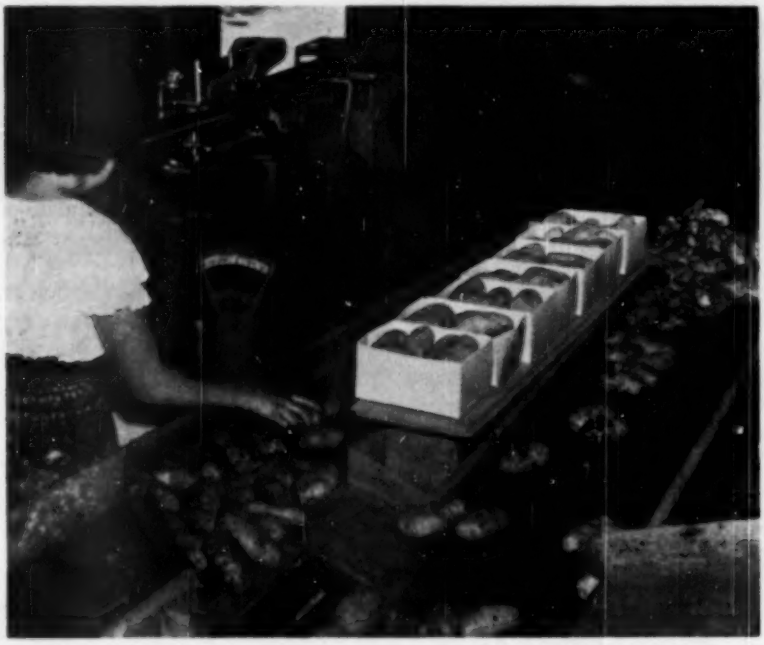
by reports of the United States support program, would like to avoid any Government interference, and let the potato business return to normal stability.

In this area the indications are that acreage will be reduced sharply, but possibly there will be an increase in higher quality Foundation seed—E. D. Reid

Province of Ontario

Resolutions approved at a recent meeting of the potato section, of the Ontario Crop Improvement Association, favored the establishment of restricted areas for certified seed, and urged that suitable legislation regarding same be prepared for forthcoming session of the Legislature. Potato growers of the Cochrane area, requested that Cochrane be selected as one of the first areas to come under the proposal; they further asked that the freight assistance on seed potatoes from Northern Ontario become a permanent policy. Growers in the Shelburne—Hornings Mills area of Dufferin County and also those in Hanmer—Blezard Valley of the Sudbury District were commended for the construction of central co-operative storage and packing facilities and recommended that similar procedure be adopted in other suitable potato-growing areas. Dealers were also complimented for progress made in modern storage and merchandising. Another resolution requested that regulations be brought into effect to insure the marketing of potatoes in standard sized bags. The meeting requested that a news letter service to potato growers be established and that further research be undertaken to determine the effect of plant nutrients with special emphasis on the use of phosphate on the cooking quality of potatoes. The growers commended the work of the scab research committee for their encouraging report, and to the Farm Economics Staff for their survey and detailed report on costs of production. They further requested that work on these two projects be continued and enlarged.

Thanks were extended for co-operation of many service clubs, municipal and county councils, commercial companies and community-spirited local citizens for their support in making high yield clubs such a success. Members of the Potato Growers' Committee nominated and elected the following to represent their respective areas for the coming year: G. A. Hackett, Cochrane; W. A. Vail, Denfield; Edgar Hewitt, Simcoe, E. G. Snyder, Preston; Clifford Faint, Hornings Mills; Roy Hickling, Barrie; Howard Harper, Goodwood; Chas. McGuire, Colborne; Lloyd Logan, Kemptville. R. E. Goodin, Toronto, is Secretary of the Committee which also includes representatives of the Dominion and Provincial Departments of Agriculture.—R. E. Goodin.



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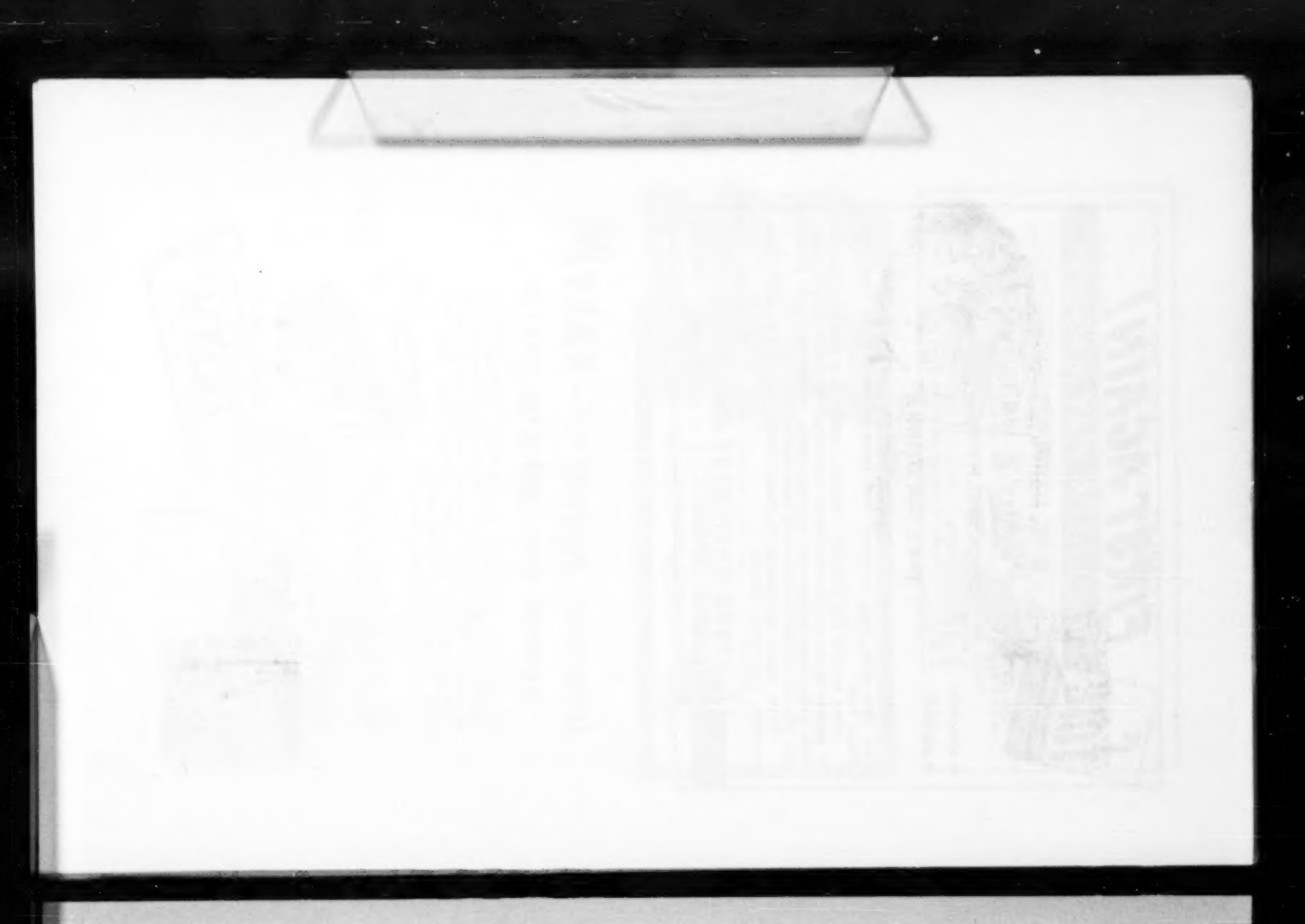

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